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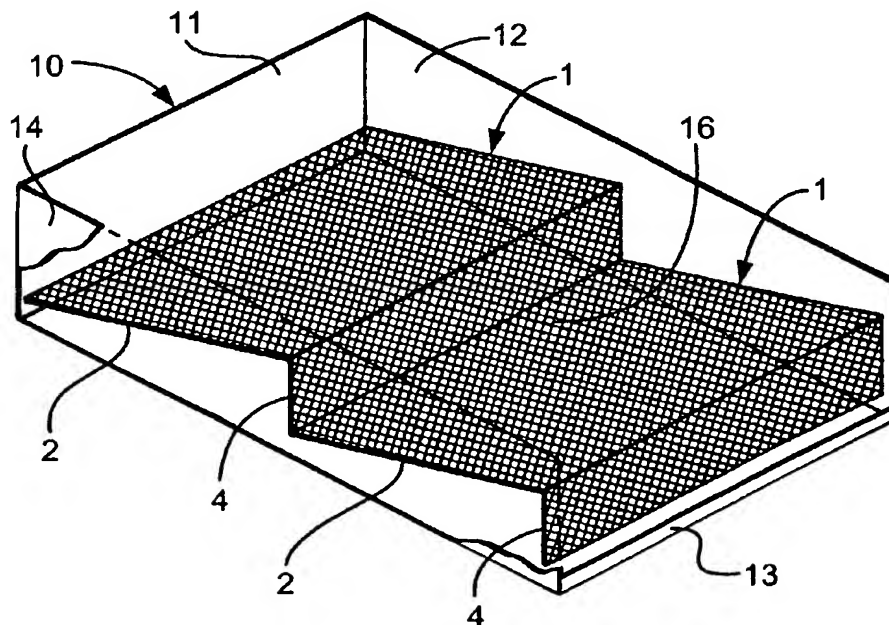
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(54) Title: A SCREEN ASSEMBLY FOR A VIBRATORY SEPARATOR



(57) Abstract: A screen assembly for a vibratory separator, the screen assembly comprising a first and second screen portion (2, 4) each comprising a layer of screening material, said first screen portion (2) at an angle to said second screen portion (4). A screen assembly for a vibratory separator, said screen assembly comprising a layer of screening material having a raised portion of screening material therein, such that, in use, the raised portion facilitates removal of liquid from the screen assembly to reduce the mass of material on the screen assembly.

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A SCREEN ASSEMBLY FOR A VIBRATORY SEPARATOR

The present invention relates to a screen assembly for a vibratory separator. The invention particularly, but not exclusively relates to a screen assembly for a shale shaker used in the process of separating particles and solids from drilling mud in the construction of an oil, gas or water well.

The need for solids control in drilling mud used in hydrocarbon well drilling is well known in the prior art. Drilling mud, typically a mixture of clay and water and various additives, is pumped down through a hollow drill string such as a pipe, drill collar or bit, into a well being drilled and exits through holes in a drillbit. The mud picks up cuttings such as rock and other solids from the well and carries them upwardly away from the bit and out of the well in an annular space between the well walls and the drill string. At the top of the well, the solids-laden mud is discharged over a shale shaker, a device which typically has a series of screens arranged in tiered or flat disposition with respect to each other. The prior art discloses a wide variety of vibrating screens and devices which use them, known as shale shakers. The screens catch and remove solids from the mud as the mud passes through them. If drilled particles and solids are not removed from the mud used during the drilling operation, re-circulation of the drilled solids can create weight, viscosity, and gel problems in the mud, as well as increasing wear on mud pumps and other mechanical equipment used for drilling.

In some shale shakers a fine screen cloth is used with the vibrating screen. The screen may have two or more overlying layers of screen cloth. The prior art discloses that the layers may be adhered or bonded together; and that a support, supports, or a perforated or apertured plate or frame may be used beneath the

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screen or screens. The screen is held taught and resiliently suspended or mounted upon a support and is caused to vibrate by a vibrating mechanism, such as an unbalanced weight on a rotating shaft connected to the frame. Alternatively, the screen may be tensioned in the shale shaker by means of a hook strip arrangement. Each screen may be vibrated by vibratory equipment to create a flow of trapped solids on top surfaces of the screen for removal and disposal of solids. The fineness or coarseness of the mesh of a screen may vary depending upon mud flow rate and the size of the solids to be removed.

Many screens used with shale shakers are flat or nearly flat (i.e. substantially two-dimensional). Other screens, due to corrugated, depressed, or raised surfaces are three-dimensional. U.S. Patents 5,417,793; 5,417,858; and 5,417,859 disclose non-flat screens for use with shale shakers. These screens have a lower planar apertured plate with a multiplicity of spaced-apart apertures or openings therethrough. Undersides of troughs of undulating screening material are bonded to the apertured plate.

The screens are mounted generally horizontally in a shale shaker that imparts either a rapidly reciprocating linear, elliptical or circular motion to the screen. Material from which particles are to be separated is poured onto a back end of the vibrating screen, usually from a pan mounted above the screen. The material generally flows toward the front end of the screen. Large particles are unable to move through the screen remaining on top of the screen and moving toward the front of the screen where they are collected. The smaller particles and fluid flows through the screen and collects in a pan beneath the screen.

A vibrating screen may be formed from one or more

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layers of wire mesh. Wire mesh is generally described with reference to the diameter of the wires from which it is woven, the number wires per unit length (called a mesh count) and the shape or size of the openings between  
5 wires. Wire mesh comes in various grades. "Market" grade mesh generally has wires of relative large diameter. "Mill" grade has comparatively smaller diameter wires and "bolting cloth" may have the smallest diameter wire. The type of mesh chosen depends on the  
10 application. The related art section of each of the above-identified applications and patents is incorporated here fully by reference.

WO 96/33792 discloses one example of a typical prior art shale shaker in which screen assemblies will be  
15 arranged.

US-A-5,190,645 discloses a shale shaker system. A well is being drilled by a bit carried on a string of drill pipe as drilling mud is pumped by a pump into the drill pipe and out through nozzles in the bit. The mud  
20 cools and cleans the cutters of the bit and then passes up through the well annulus flushing cuttings out with it. After the mud is removed from the well annulus, it is treated before being pumped back into the pipe. The mud enters a shale shaker where the relatively large  
25 cuttings are removed. The mud then enters a degasser where gas can be removed if necessary. The degasser may be automatically turned on and off, as needed, in response to an electric or other suitable signal produced by a computer and communicated to degasser. The computer  
30 produces the signal as a function of data from a sensor assembly associated with shale shaker. The mud then passes to a desander and (or a desilter), for removal of smaller solids picked up in the well. The mud next passes to a treating station where, if necessary  
35 conditioning media, such as barite, may be added.

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Suitable flow controls e.g. a valve, control the flow of media. The valve may be automatically operated by an electric or other suitable signal produced by the computer as a function of the data from sensor assembly.

5 From the treatment station, the mud is directed to a tank from which a pump takes suction, to be re-cycled through the well. The system shown in exemplary, and it will be understood that additional components of the same types (e.g. additional treatment stations) or other types (e.g.

10 centrifuges) could be included. Such a shale shaker or vibrator separator apparatus may employ any known screen or screens and may have a single screen or combination of two or more screens, one above the other, as is well known in the art.

15 It has been found by the applicant that it is beneficial to reduce the weight of material on the screen assemblies as quickly as possible in order to increase the efficiency of the shaking process. Reduction of weight may be achieved by ridding the material of liquid

20 as quickly as possible. PCT Application Number PCT/GB01/04667, unpublished at the date of filing of this application discloses this problem.

It has been noted that screen assemblies which are able to remove liquid quickly, would enable standard

25 shale shakers, such as the VSM-100 and VSM-300 by Varco, Inc. to have at least some of the benefits stated above.

According to the present invention there is provided a screen assembly for a vibratory separator, the screen assembly comprising a first and second screen portion

30 each comprising a layer of screening material, said first screen portion at an angle to said second screen portion.

The invention also provides a screen assembly for a vibratory separator, said screen assembly comprising a layer of screening material having a raised portion of

35 screening material therein, such that, in use, the raised

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portion facilitates removal of liquid from the screen assembly to reduce the mass of material on the screen assembly.

5 The invention also provides a vibratory shaker provided with the screen assembly of the invention.

The invention also provides a method of screening material using the vibratory shaker of the present invention.

10 Other aspects and features are set out in the depending claims.

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For a better understanding of the present invention, reference will now be made, by way of example, to the accompanying drawings, in which:

5       Figure 1A is a perspective view of a screen assembly in accordance with the present invention;

      Figure 1B is a perspective view of a basket with two screen assemblies as shown in Figure 1A arranged therein;

10       Figures 1C is a side view of two screen assemblies, each a further embodiment of a screen assembly in accordance with the present invention;

      Figures 1D is a side view of two screen assemblies, each a further embodiment of a screen assembly in accordance with the present invention;

15       Figures 1E is a side view of two screen assemblies, each a further embodiment of a screen assembly in accordance with the present invention;

20       Figure 2A is a perspective view of a further embodiment of a screen assembly in accordance with the present invention;

      Figure 2B is a perspective view of a basket with a screen assembly of Figure 2A arranged therein;

25       Figures 3 to 7 are perspective views of further embodiments of screen assemblies in accordance with the present invention;

      Figures 8 to 10 are enlarged perspective views of a common part of the screen assemblies shown in Figures 2A to 7, shown with various types of endings, which are in accordance with the present invention;

30       Figures 11 to 13 are underneath plan views of screen assemblies in accordance with the present invention;

      Figure 14A is a top view and Figure 14B is an end view of a screen in accordance with the present invention; and

35       Figure 15 is a perspective view of part of a screen

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in accordance with the present invention.

Figure 1A shows a screen assembly 1 in accordance with the present invention for a vibratory separator, shaker or shale shaker which has a first part 2 and a second part 4. The second part 4 is connected to or formed integrally of the first part 2. In one particular aspect an original generally flat screen is folded along a line 3 to form the second part 4. In other embodiments a separate piece forms the second part 4 and it is positioned adjacent and/or connected [e.g., but not limited to: by sewing; by welding; tack welding; glue; adhesives; soldering; sintering; connectors (e.g. but not limited to bolts, staples, screws, releasably co-operating fastener material such as Velcro (TM) material, rivets); and/or sintering] to the first part 2. When separate pieces are used, in one aspect, the basket has separate mounting structure and/or devices for each piece (e.g. but not limited to hookstrip structures; spring tension bolts; wedging structures and/or apparatus, brackets and/or channel structures in which screen parts or frames are positioned; releasable locking devices; clamps, etc.). In other aspects a frame (see e.g. Figure 4) has frame support portions corresponding to the parts 2 and 4 and each part is connected to its corresponding frame portion. In one aspect the part 4 is a separate piece held or mounted in a basket (e.g. as basket 10, Figure 1B or in any known suitable basket); held or mounted with any known suitable mounting structure or device (as may be any screen or screen part disclosed herein). The part 2 is then installed so that it holds the part 4 in place, with a portion of the part 2 contacting and abutting a top portion of the part 4. In one aspect such contact is a sealing contact. Optionally a gasket or other suitable sealing material may be used between the parts 2 and 4 where they abut each other (as

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may be the case with any two screens or screen parts herein).

As shown the angle 5 between the first part 2 and the second part 4 is about ninety degrees. It is within the scope of this invention for the angle 5 to be any desired angle and, in certain aspects, this angle ranges between forty-five and ninety degrees and in other aspects to range between forty-five and one hundred thirty five degrees.

The second part 2 has screen mesh 6 for the first part 2 and screen mesh 8 for the second part 4. These screen meshes may be identical, e.g. but not limited to, both fine screen material or both coarse screening material; or they may be made of different screening material. It is also within the scope of this invention for either or both parts 2, 4 (as with any screen or screen part herein) to include multiple (two, three, four or more) flat or 3-dimensional (e.g. corrugated; undulating) such as those shown in co-pending PCT Publication Number WO 00/64558 layers of screening material and/or mesh, including, but not limited to, any combination of layers disclosed or referred to herein; bonded, connected, sintered and/or sewn together (or not) as any disclosed or referred to herein; and with any shape screen openings including, but not limited to square, diamond-shaped, hexagonal and rectangular - and any such layer(s) may be bonded to a support and/or support layer(s) [e.g. but not limited to a support layer of coarse mesh; a perforated plate; a strip support; or a frame]. Either part 2 or 4 that has multiple layers of screening material may have the layers free of each other (i.e., unbonded, unconnected, etc.) and the layers [all layers and/or support layer(s)] may be flattened and/or calendered together or not. In one particular aspect a unitary support structure is formed in a shape

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corresponding to the final positioning of a two part screen (e.g. as with parts 2, 4 as shown in Figure 1A) and one or more screen layers are then applied and/or connected and/or bonded to the unitary support.

5 Alternatively a two part support is made and the two parts are connected - one for a first screen part (e.g. part 2) and one for a second screen part (e.g. part 4).

Figure 1B shows a typical basket 10 for a vibratory separator apparatus. The basket typically is an integral  
10 part of the vibratory separator apparatus. The basket 10 has two screen assemblies 1 placed end-to-end therein. Any suitable known mounting apparatus and/or devices may be used to mount (in certain aspects, releasably mount) the screen assemblies 1 in the basket 10. The basket 10  
15 has a first end 11 at which material to be handled by a vibratory separator is introduced into the basket; sides 12 and 14; and a material exit end 13. Material passing through the screen assemblies 1 falls through them and then through an open bottom 16 of the basket 10 or onto  
20 another screen assembly below the assemblies 1. An optional splash plate (not shown) over part of the screen at a fluid introduction end may be used in the basket 10 onto which material is fed before it flows over the screen assembly 1 at the first end 11.

25 As shown there are two screens 1 in the basket 10; but the screens 1 may be any suitable length so that any desired number of screen assemblies (e.g. three, four, five or more) may be disposed end-to-end in the basket 10. It is also within the scope of this invention to  
30 delete a screen assembly 1 (or screen assemblies 1 when there are three or more) from the basket 10 and replace it (or them) with any suitable known screen assembly, including, but not limited to any screen assembly disclosed or referred to herein and in our co-pending  
35 applications such as in PCT Publication Number WO

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00/64558.

It is within the scope of the present invention to use two or more screen assemblies 1 stacked one on top of the other in the basket 10. It is within the scope of this invention to use one or more screen assemblies 1 (and/or any screen assembly disclosed in Figures 2A to 13) with any basket as disclosed in U.S. Application Ser. No. 09/716,176 filed 11/17/00 incorporated fully herein for all purposes and co-owned with the present invention.

Figures 1C to 1E show screens S1 to S6 similar to those of Figures 1A and 1B; but the screen S1 has a lower lip 1A upon which an end of the screen S2 sealingly rests, is positioned, or is connected (e.g., but not limited to, by glue; adhesive; connectors such as screws, staples, nuts and bolts; welding; tack welding; releasably cooperating fastener material - e.g. Velcro (TM) material; clamps; and/or rivets). The screen S3 has a lower lip 1B under which rests an end of the screen S4. This end of the screen S4 is in sealing contact with the lip. Each screen S1, S3, and S5 has an optional splash plate or impact plate 7 which fluid introduced onto the screen hits initially then flows onto the screen. Instead of the lips 1A, 1B, a groove structure 9 is used to accept the end of the adjacent screen assembly on the screens S5, S6 (Figure 1E) to sealingly connect one screen to another - with an end of the screen S6 positioned in a groove of the screen S5. Sealing material and/or a gasket may be used in the groove and/or on the end of the screen S6 in the groove. Any seal structure mentioned above may be used with any screens disclosed in Figures 1A to 13 (and with any screen disclosed herein).

Figure 2A shows a screen assembly 20 in accordance with the present invention which has two side portions 22, 24 of screening material and between them a raised

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portion 26 that includes sides 27, 28 that meet at an apex 25. The screening material may be any as described for the screen assembly 1 in any combination of layers or form as described for the screen assembly 1. As shown

5 the apex 25 is about 10cm (four inches) above the screen portions 22, 24 and the angle between the sides 27, 28 is about sixty degrees. This angle can be any suitable desired angle and, in certain aspects, ranges between thirty and ninety degrees. If the angle is ninety degrees

10 or close to ninety degrees, a box section is appropriate, rather than a triangular section. The apex 25 may be any desired height above the screen portions 22, 24 and, in certain embodiments, is between one and six inches above the screen 22, 24 and in one aspect is at least one-and a

15 half or at least two inches above the rest of the screen. It is within the scope of this invention to have one, two, three, four or more raised portions 26 spaced-apart on a screen assembly such as the screen assembly 20; and the cross-section of such raised portions viewed on end

20 may be as shown in Figure 2A or of an end shape as shown for any raised portion, insert or ramp disclosed herein. The bottom of the raised portion 26 may be open; may have a plurality of spaced-apart strips or bars across it; may be plugged; may have mesh or screen covering it; or may

25 have a solid sheet or piece blocking it off. Similarly, the open ends of the raised portion 26 may be open or have any of the structures possible as listed for the bottom of the raised portion 26. In one aspect the raised portion is made of an integral mount of a screen

30 so that there are no open ends of the raised portion. In one such screen an amount of screening material is pushed out from the screen to form the raised portion(s).

Figure 2B shows a basket 29 (like the basket 10) with a screen assembly 20 mounted therein. Shown

35 schematically is a second screen assembly 21 (shown

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schematically with a blank surface) which may be like the screen assembly 20, the screen assembly 1, or any other screen assembly disclosed or referred to herein. One, two, or more screen assemblies 20 may be stacked one on top of the other; and one screen assembly 20 may be inverted on top of another so that the apex of the raised portion(s) of the inverted screen assembly points down instead of up (and if so inverted the layers of screen material may also be rearranged with finer material on top).

Figure 3 shows a screen assembly 30, like the screen assembly 1, with side hookstrips 31, 32 for mounting the screen assembly in a basket. (Such hookstrips may be provided for any screen or screen part disclosed herein.) Hookstrips may also be provided for the downwardly projecting part of the screen.

Figure 4 shows a screen assembly 34, like the screen assembly 1, with the screening material mounted on a frame with frame parts 35 and 36. Any known frame structure may be used for the parts 35 and 36. The frame is preferably rigid such that the screening material may be stretched and held in a stretched state by attachment to the frame. Alternatively a perforated plate or sheet metal with holes, openings, apertures or perforations may be used (for any screen assembly 10, 20, 40, 44) under either or both screen portions or a strip support with a series of support strips (which is not the legal equivalent of a perforated plate or of a frame with a grid of crossmembers) may be used.

Figure 5 shows a screen assembly 40, like the screen assembly 20, with side hookstrips 41, 42 for mounting the screen assembly in a basket. Any suitable lower support may be used with this screen. The two flat screening areas of the screen assembly either side of the triangular projection may be joined by strips like those

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shown in Figure 12, or by screening material as shown in Figure 13, or may have an underlying apertured plate spanning between the hook strips 41, 42.

5 Figure 6 shows a screen assembly 44, like the screen assembly 20, with the screen portions mounted on a frame 45. Any known frame structure may be used, such as a rigid frame on which the screening cloth may be stretched and attached. The frame may be rigid to hold the tensile forces in the screening cloth induced by the stretching.

10 Alternatively, the frame could be flexible such that upon clamping in a vibratory shaker, the frame is held rigid and the screening material held stretched.

Figure 7 shows a screen assembly 50 in accordance with the present invention with a top portion 52 like the screen assembly 20, Figure 2A [or like any screen assembly discussed herein with a raised portion or portions with an apex (or apices)]; and with a portion 54, like the portion 4 of the screen assembly 1, Figure 1A (or like such a portion of any screen assembly disclosed above).

15 20

Any of the screen assemblies of Figures 1A to 13 may be used, e.g., in the apparatuses of Figures 33 and 34B discussed above. Any screen assembly in Figures 1A to 13 may employ any known support as a lowermost structure, including, but not limited to, known perforated plates; apertured plates; sheet metal with holes, perforations, openings, or apertures; strip supports; frames; very coarse mesh; and/or expanded metal.

25

Figures 8 to 10 show various ways in accordance with the present invention for providing a connection across the end of a raised portion 26 of a screen assembly in accordance with the present invention. In Figure 8 two cross strips 26a and 26b are connected to sides of the raised portion 26 to provide strength and to prevent the sides of the raised portion from separating apart. This

30 35

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is done in Figure 9 with a piece of screen 26c and in Figure 10 with a solid plug 26d. Any known connector, securement, securing means, or connection means may be used to connect the items 26a to 26d over the ends of the raised portion 26, such as welding, resins or a hot melt glue. In one aspect only one of the cross strips is used. It is to be understood that both ends of the raised portion (of any screen disclosed herein) may have any or any combination of the items 26a to 26d. Also any of these items may be used with any of the structures in Figures 11 to 13.

Figures 11 to 13 show structures on the bottom of a screen SCN that has a raised portion 26 which prevent the sides of the raised portion from separating. Figure 11 shows a solid strip, sheet, or plate 26e (which may also be perforated and/or have holes, openings, and/or apertures through it). Filtrate may be allowed to flow through the ends of the raised portion 26. Figure 12 shows a plurality of strips or bars 26f and 26g connected between sides of a raised portion 26. Any one, two or three of the strips or bars may be omitted; and any such additional strips or bars may be added. Figure 13 shows a piece of screen mesh 26h connected between the sides of a raised portion 26. Any suitable screen, expanded metal, or mesh may be used. The items 26e to 26h may be connected across the raised portion to its sides by any connection or attachment means or method disclosed herein.

Figures 14A and 14B illustrate that any screen or screen portion of Figures 1A to 13 may have a three-dimensional layer or layers of screen material 61 on a support 64 (any known support), optionally with mounting structure 62 (which may be any known suitable mounting apparatus, mounting device, draw-bar-bolt structure, hookstrips, etc.). The material 61 may be any known

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multi-layer screening material, screen, and/or mesh, including, but not limited to, those disclosed herein.

Figure 15 shows a part of a screen assembly in accordance with the present invention, the screen assembly having a raised portion 26 (as in Figure 10). A pool, mass, or cake of material to be screened 65 has an upper surface 66 at a height  $h$  above a base of the raised portion 26. Preferably the raised portion's top 26t (and the top of any raised portion disclosed herein, Figures 2 to 13) is at least 2.5cm (one inch), more preferably at least 4cm (one and a half inch), and most preferably at least 5cm (two inches) above the surface 66. Typically the tops of the ridges of prior art three-dimensional screens are not more than an inch above a pool or mass of material to be screened.

The screening material may be three-dimensional, which may include undulations. The raised portion may be triangular, square or rectangular, or with two straight sides and a curved top.

Although only one raised portion is shown, two or more raised portions may be provided. However, one has been sufficient to solve the technical problem stated herein.

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CLAIMS

1. A screen assembly for a vibratory separator, the screen assembly comprising a having a first (2) and second (4) screen portion each comprising a layer of screening material (6,8), said first screen portion (2) at an angle to said second screen portion (4).
2. A screen assembly as claimed in Claim 1, wherein said screen assembly has a leading end on which material to be filtered is introduced and a trailing end opposing the leading end, said second screen portion (4) located at said trailing end.
3. A screen assembly as claimed in Claim 1 or 2, wherein the first screen portion (2) is the major portion and the second screen portion (4) is the minor portion.
4. A screen assembly as claimed in Claim 3, wherein the first screen portion (2) has a length and the second screen (4) has a length between 1% to 30% of the length of the first screen portion(2).
5. A screen assembly as claimed in any preceding claim, wherein said second screen portion (4) projects down from said first screen portion (2).
6. A screen assembly as claimed in any preceding claim, wherein the second screen portion (4) has a seal structure (1A,1B,9) for sealingly abutting an end of another screen assembly.
7. A screen assembly as claimed in Claim 6, wherein the seal structure is a lip projecting (1A,1B) from the trailing end of the screen assembly.
8. A screen assembly as claimed in Claim 6 or 7, wherein the seal structure comprises a groove (9) on the second screen portion for receiving an end of another screen assembly.
9. A screen assembly as claimed in any preceding claim, wherein the screening material (6) of the first screen portion (2) is substantially flat or three-dimensional.

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10. A screen assembly as claimed in any preceding claim, wherein the screening material (8) of the second screen portion (4) is substantially flat or three-dimensional.
11. A screen assembly as claimed in any preceding claim,  
5 wherein the first screen portion (2) comprises at least a second layer of screening material overlying the first.
12. A screen assembly as claimed in any preceding claim, wherein the second screen portion comprises at least a second layer of screening material overlying the first.
- 10 13. A screen assembly as claimed in any preceding claim, further comprising a support (35) beneath and supporting the first screen portion.
14. A screen assembly as claimed in any preceding claim, wherein comprising a support (36) beneath and supporting  
15 the second screen portion.
15. A screen assembly as claimed in any preceding claim, wherein the second screen portion (4) is at an angle to the first screen portion (2) of between forty-five and one-hundred-thirty-five degrees.
- 20 16. A screen assembly as claimed in any preceding claim, further comprising at least one raised portion (26) projecting upwardly from the first screen portion (2).
17. A screen assembly as claimed in Claim 17, wherein the at least one raised portion (26) has two open ends.
- 25 18. A screen assembly as claimed in Claim 17, wherein the open ends each have a plug (26d) therein.
19. A screen assembly as claimed in Claim 16 to 18, wherein the at least one raised portion (26) comprises two spaced-apart sides and the screen further comprising  
30 at least one connection member (26g) connecting the sides of the at least one raised portion (26) together.
20. A screen assembly as claimed in Claim 19, wherein the at least one connection member is at least one strip (26a,26b) across each of the open ends of the at least  
35 one raised portion.

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21. A screen assembly as claimed in Claim 19 or 20, wherein the at least one connection member (26a) is between the open ends of the at least one raised portion (26) and at a bottom of the spaced-apart sides thereof.
- 5 22. A screen assembly as claimed in Claim 19 to 21, wherein the at least one raised portion (26) comprises spaced-apart sides with at least one connection member connected to and between the spaced-apart sides to prevent them from separating.
- 10 23. A screen assembly as claimed in any of Claims 16 to 22, wherein the at least one raised portion (26) has a top part at least 10cm (four inches) above the first screen portion.
- 15 24. A screen assembly as claimed in any of Claims 16 to 23, wherein the at least one raised portion (26) extends from a first end of the first screen portion (2) at which fluid to be treated by the screen assembly is introduced onto the first screen portion to a second end of the first screen portion (2), the at least one raised portion
- 20 (26) extending across a length of the first screen portion (2).
- 25 25. A screen assembly as claimed in any of Claims 16 to 24, wherein the at least one raised portion (26) comprises two sides meeting at a top of the raised portion at an angle.
26. A screen assembly as claimed in Claim 25, wherein the angle ranges between 30 and 60 degrees.
27. A screen assembly as claimed in any of Claims 16 to 26, wherein the raised projection (26) projects upwardly
- 30 from said first screen portion.
28. A screen assembly as claimed in any preceding claim, further comprising side hookstrips on the first screen portion for mounting the screen assembly in a basket.
29. A screen assembly as claimed in any preceding claim,
- 35 wherein the second screen portion (4) is formed

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integrally with the first screen portion (2).

30. A screen assembly as claimed in any preceding claim, wherein the first screen portion (2) and the second screen portion (4) are in contact with each other.

5 31. A vibratory separator comprising at least one screen assembly as claimed in any preceding claim.

32. A method to separate components of a material with the vibratory separator as claimed in Claim 31, the method comprising the steps of introducing material onto  
10 the screen assembly at a leading end, vibrating the screen assembly, separating components of the material with the first screen portion and the second screen portion.

33. A screen assembly for a vibratory separator, said  
15 screen assembly comprising a layer of screening material (22,24) having a raised portion (26) of screening material therein, such that, in use, the raised portion facilitates removal of liquid from the screen assembly to reduce the mass of material on the screen assembly.

20 34. A screen assembly as claimed in Claim 33, wherein the raised portion (26) is at least 2.5cm high.

35. A screen assembly as claimed in Claim 33, wherein the raised portion (26) is at least 4cm high.

25 36. A screen assembly as claimed in Claim 33, wherein the raised portion (26) is at least 5cm high.

37. A screen assembly as claimed in Claim 33, wherein the raised portion (26) is at least 10cm high.

30 38. A screen assembly as claimed in any of Claims 33 to 37, wherein said raised portion (26) is substantially triangular in cross-section.

39. A screen assembly as claimed in any of Claims 33 to 38, wherein the at least one raised portion (26) has two open ends.

35 40. A screen assembly as claimed in any of Claims 33 to 39, wherein the open ends each have a plug (26d) therein.

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41. A screen assembly as claimed in any of Claims 33 to 40, wherein the at least one raised portion (26) comprises two spaced-apart sides and the screen further comprising at least one connection member (26a,26b,26e,26f,,26g,26h), connecting the sides of the at least one raised portion (26) together.
42. A screen assembly as claimed in Claim 41, wherein the at least one connection member (26a,26b) is at least one strip across each of the open ends of the at least one raised portion.
43. A screen assembly as claimed in Claim 41 or 42, wherein the at least one connection member is between the open ends of the at least one raised portion (26) and at a bottom of the spaced-apart sides thereof.
44. A screen assembly as claimed in Claim 41 to 43, wherein the at least one raised portion (26) comprises spaced-apart sides with at least one connection member (26a,26b,26e,26f,,26g,26h) connected to and between the spaced-apart sides to prevent them from separating.
45. A screen assembly as claimed in any of Claims 33 to 44, wherein the at least one raised portion (26) has a top part at least 10cm (four inches) above the layer of screening material (22,24).
46. A screen assembly as claimed in any of Claims 33 to 45, wherein the at least one raised portion (26) extends from a first end of the layer of screening material at which, in use, fluid to be treated by the screen assembly is introduced onto the layer of screening material to a second end of the layer of screening material, the at least one raised portion (26) extending across a length of the layer of screening material.
47. A screen assembly as claimed in any of Claims 33 to 46, wherein the at least one raised portion (26) comprises two sides meeting at a top of the raised portion at an angle.

- 21 -

48. A screen assembly as claimed in Claim 47, wherein the angle ranges between 30 and 60 degrees.

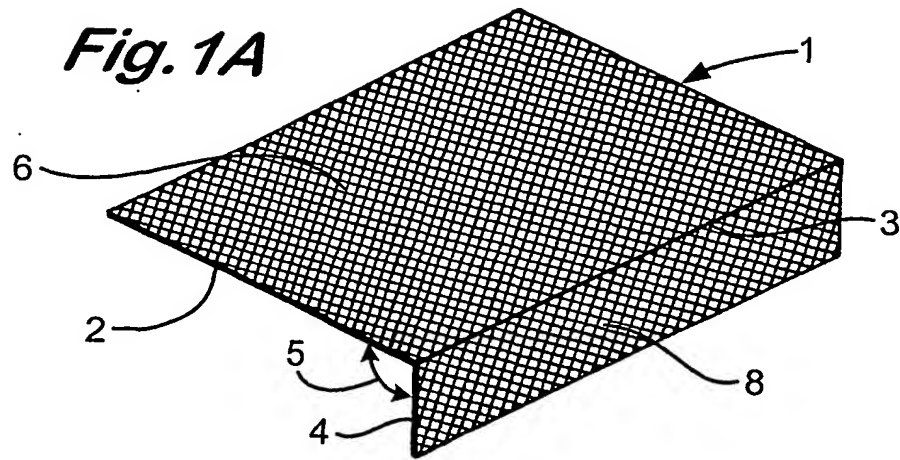
49. A screen assembly as claimed in any of Claims 33 to 48, wherein the raised portion (26) projects upwardly  
5 from said layer of screening material.

50. A method of separating components of material using the screen assembly as claimed in any of Claims 33 to 49, the method comprising the steps of introducing material to be separated on to a leading edge of said screen  
10 assembly, allowing a liquid component of said material to be separated to flow through the raised portion of screening material whilst the screen assembly is vibrated.

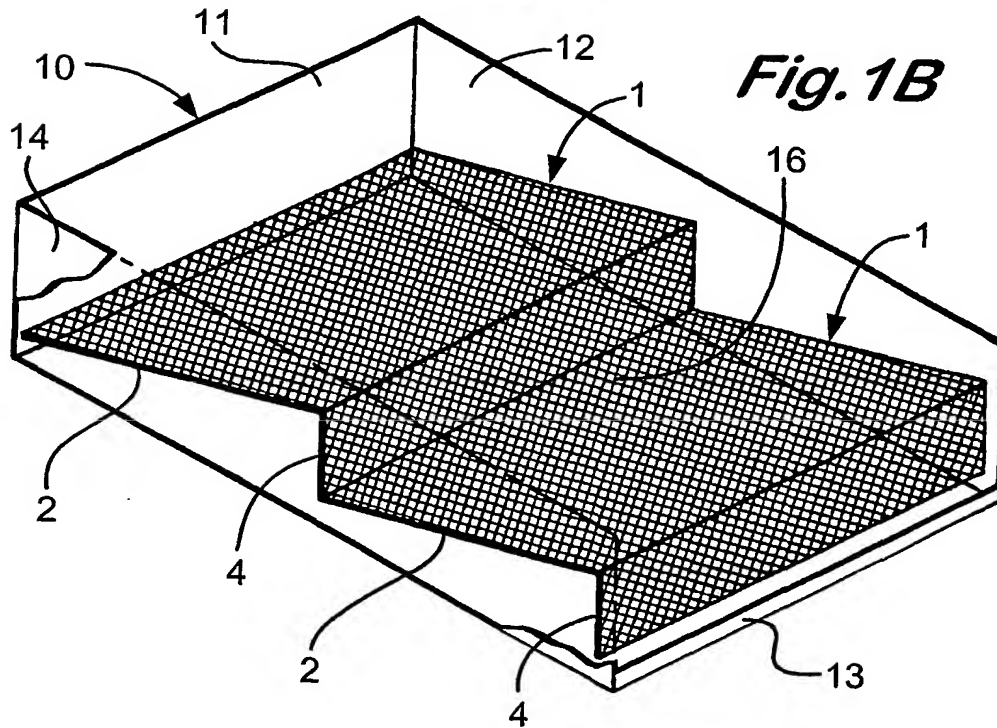
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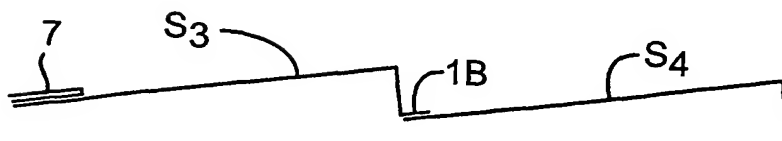
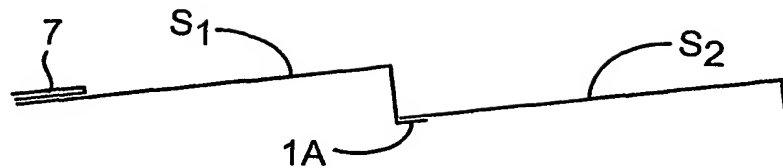
**Fig. 1A**



**Fig. 1B**

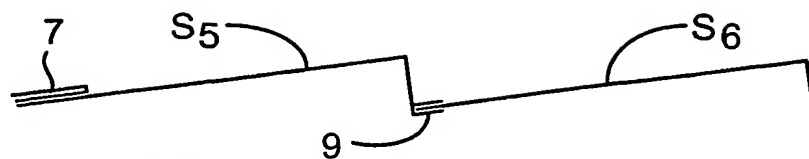
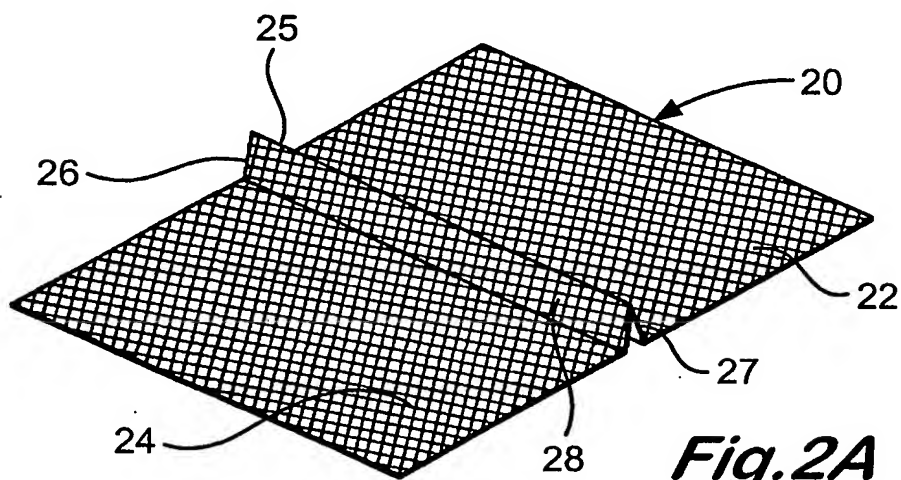
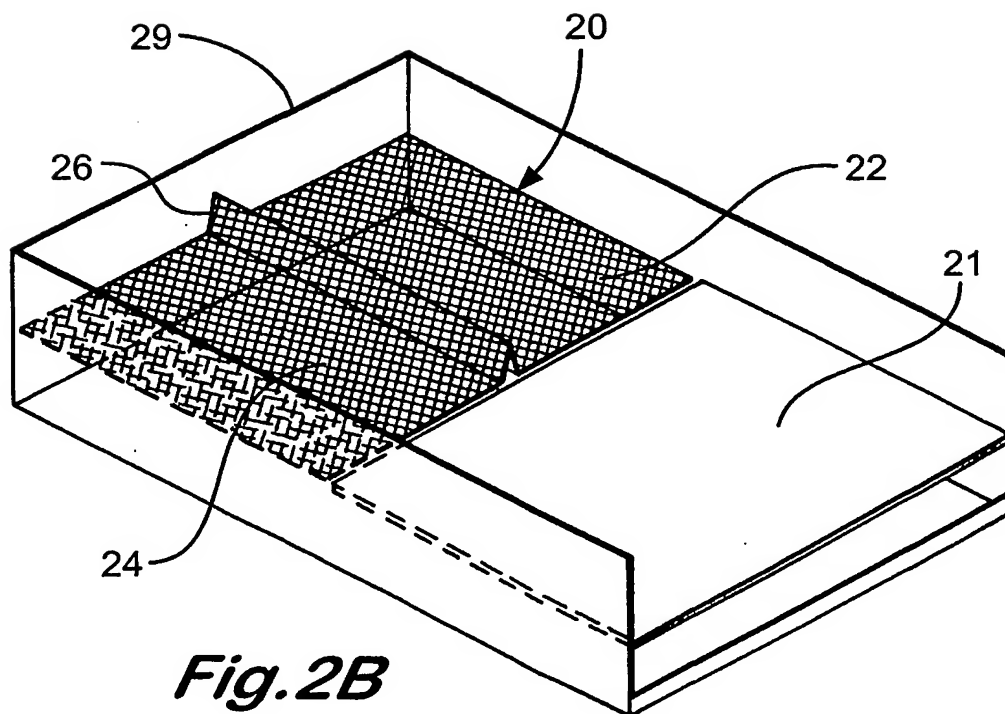


**Fig. 1C**

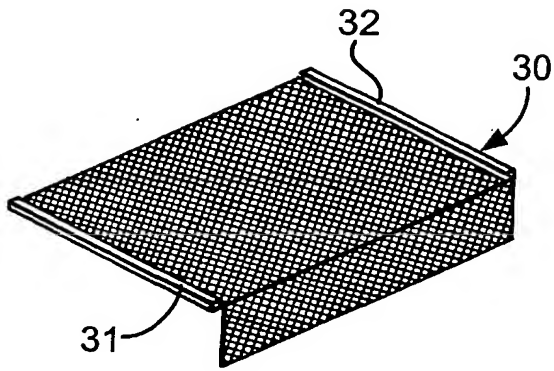


**Fig. 1D**

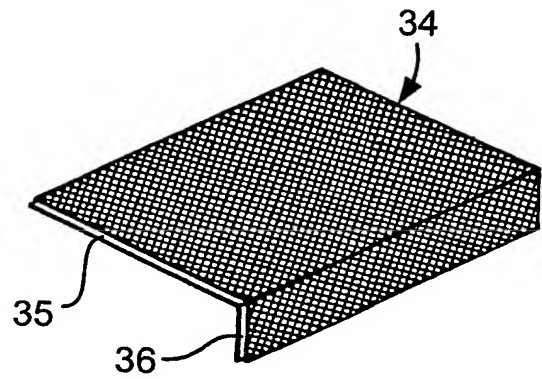
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**Fig. 1E****Fig. 2A****Fig. 2B**

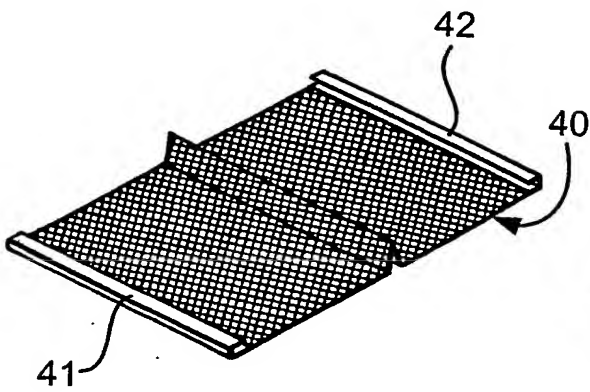
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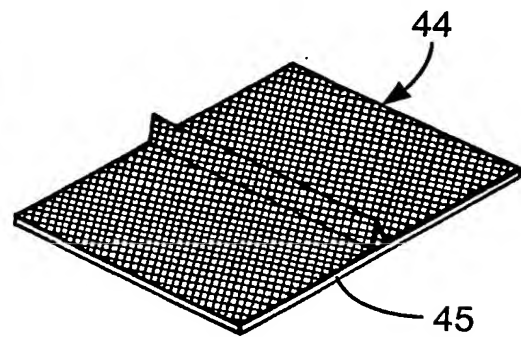
*Fig. 3*



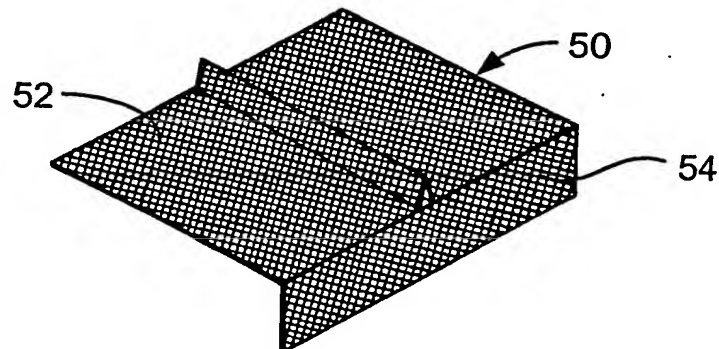
*Fig. 4*



*Fig. 5*

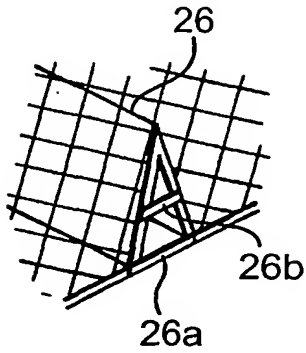


*Fig. 6*

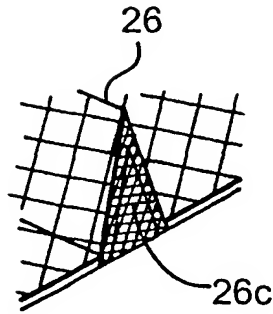


*Fig. 7*

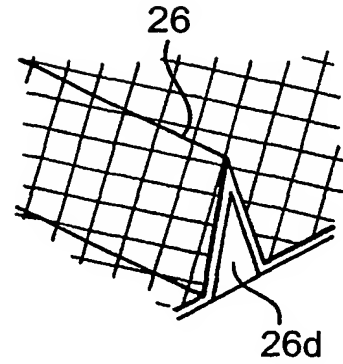
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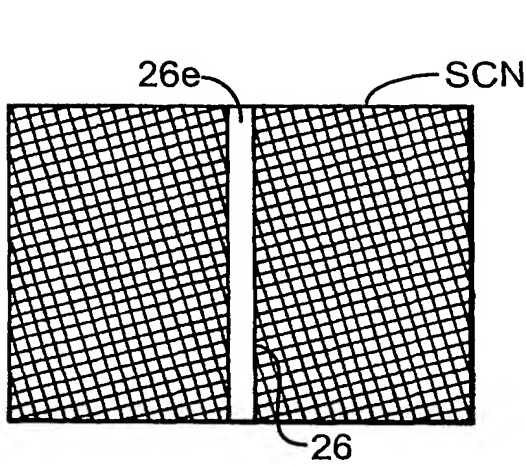
**Fig. 8**



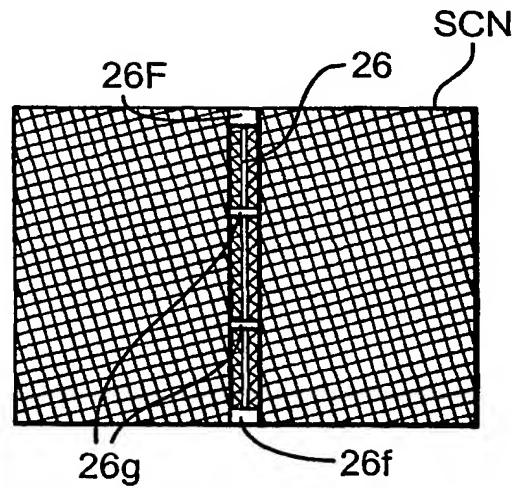
**Fig. 9**



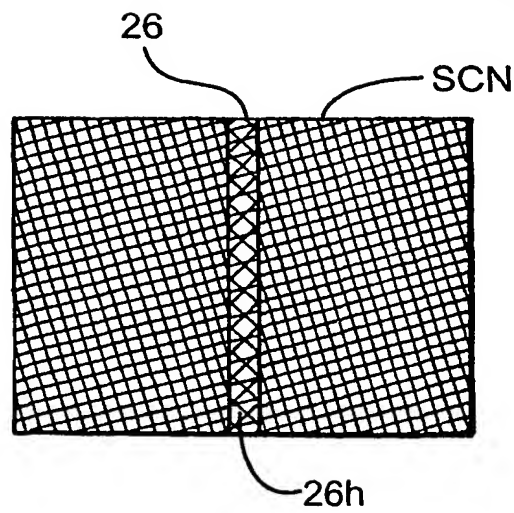
**Fig. 10**



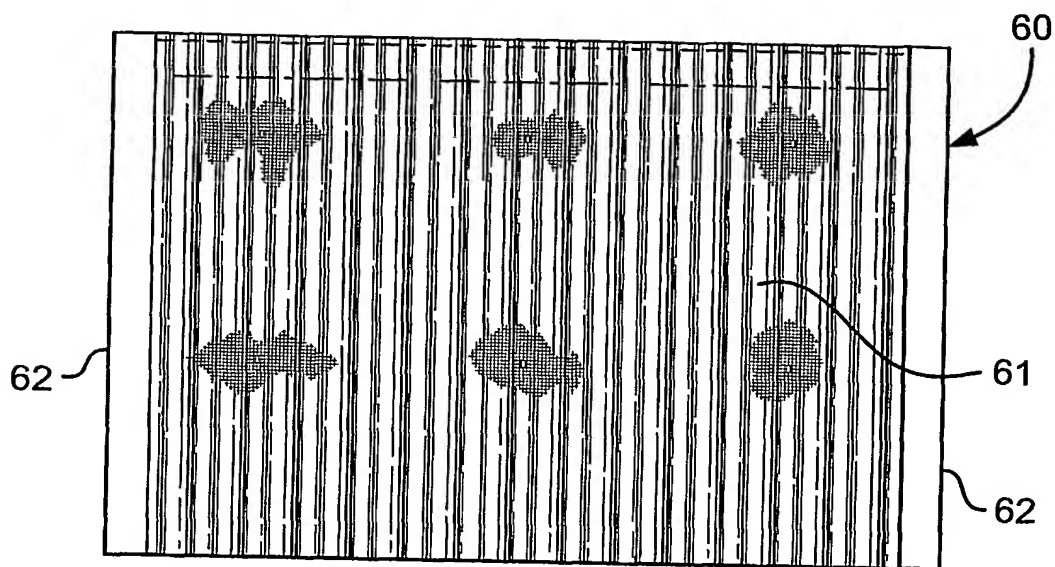
**Fig. 11**



**Fig. 12**



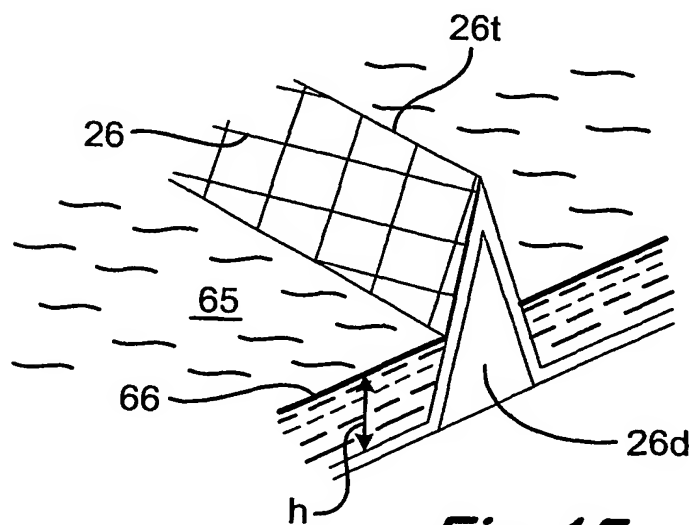
**Fig. 13**



**Fig. 14A**



**Fig. 14B**



**Fig. 15**

# INTERNATIONAL SEARCH REPORT

II National Application No  
PCT/GB 02/00733

A. CLASSIFICATION OF SUBJECT MATTER  
IPC 7 B07B1/46 B01D33/03

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)  
IPC 7 B07B B01D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 00 64558 A (TUBOSCOPE) 2 November 2000 (2000-11-02)	1-4, 9-14, 30-39, 44-48
A	page 6, line 3 -page 9, line 11 page 10, line 1 -page 11, line 3 figures 1-2H,4	16,18, 23-29
X	WO 00 25942 A (TUBOSCOPE) 11 May 2000 (2000-05-11)	1-4, 13-15, 28-37, 46-48
A	page 6, line 5 -page 8, line 5 figures 1A-4	16,19, 22,25-27
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Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Information on patent family members

International Application No

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